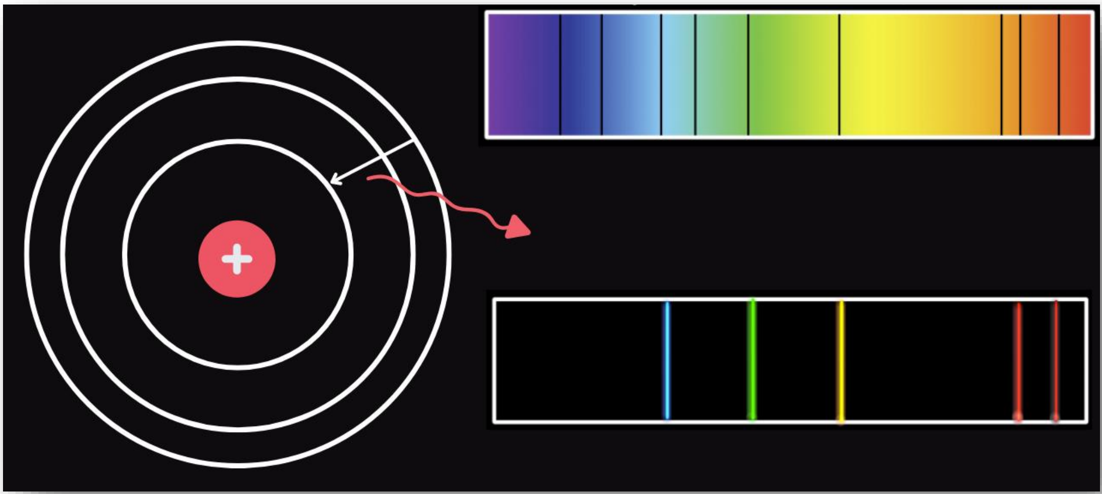
ATOMIC PHYSICS, is the scientific study of the structure of the atom, its energy states, and its interactions with other particles and with electric and magnetic fields. Atomic physics has proved to be a spectacularly successful application of quantum mechanics, which is one of the cornerstones of modern physics.

ATOMIC SPECTRA

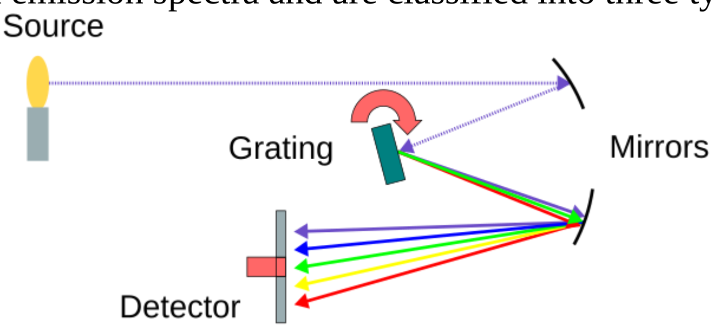
Atomic spectra deal with the spectrum of frequencies of electromagnetic radiation emitted or absorbed by an electron during transitions between different energy levels within an atom.



OPTICAL SPECTRA

An optical spectrum is obtained when light passes through a prism or a diffraction- grating. This spectrum can be obtained from the intensity and wavelength of the radiation.

The spectrum may be observed visually in the limited wavelength region to which the eye is sensitive; it may be focused on a photographic plate. The spectra obtained from radiating bodies are called emission spectra and are classified into three types

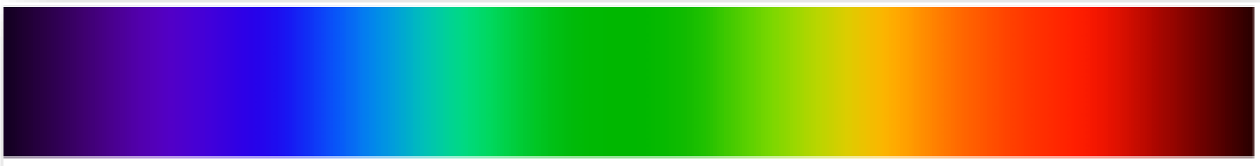


(i) Continuous spectra
(ii) Band spectra
(iii) Line spectra

CONTINUOUS SPECTRA

Solids, liquids, and dense opaque gases at high temperatures emit continuous spectra. The spectrum of the sun, or a black body, is continuous.

A continuous spectrum results when the gas pressures are higher so that collisions between the atoms broaden lines until they are smeared into a continuum. We may view a continuum spectrum as an emission spectrum in which the lines overlap with each other and can no longer be distinguished as individual emission lines.

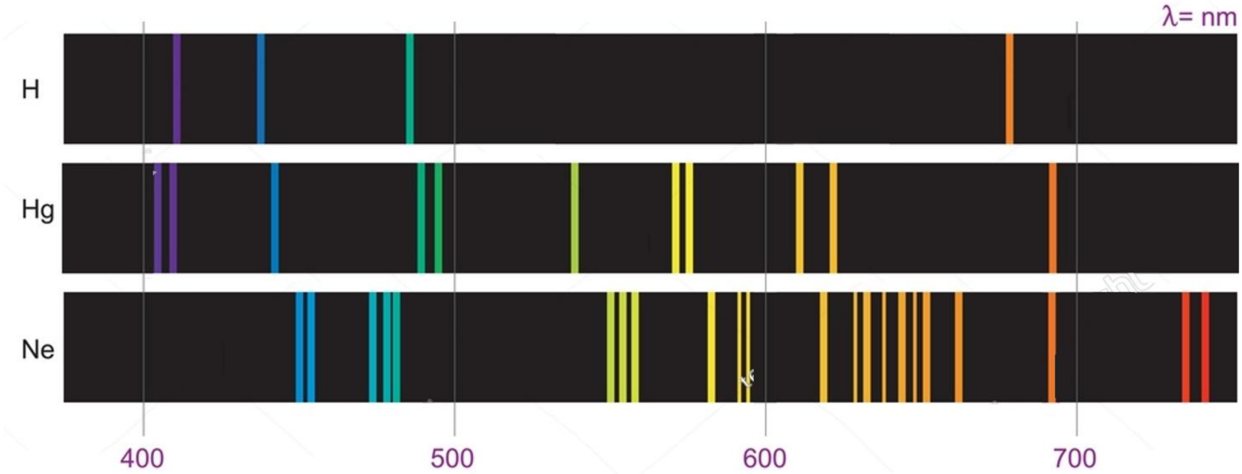


BAND SPECTRA

The wavelengths emitted by the molecular energy levels which are generally grouped into several bunches are also grouped; each group being well separated from the other. The spectrum looks like separate bands of varying colors. Such a spectrum is called a band emission spectrum.

LINE SPECTRA

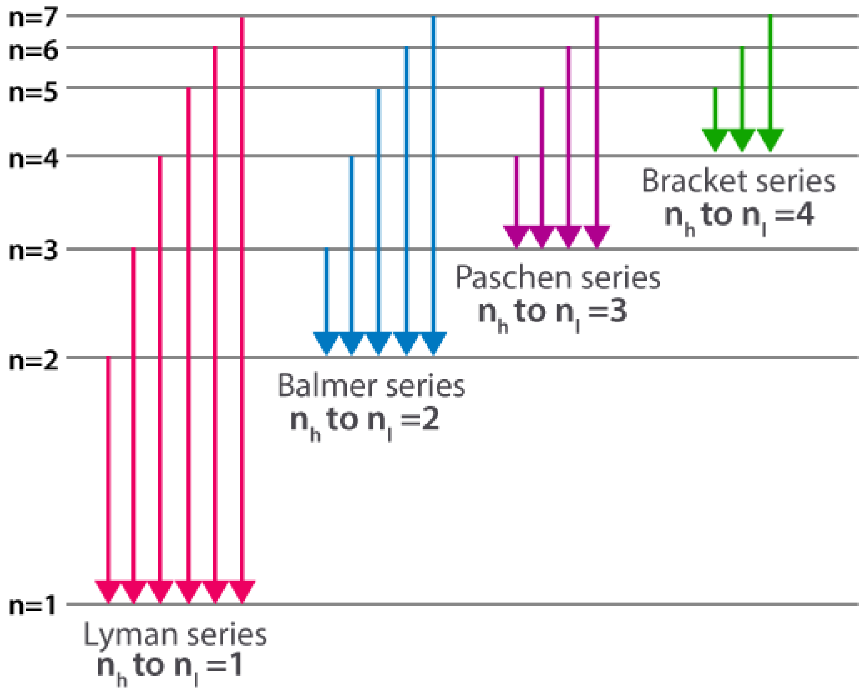
Every single atom produces a discrete line spectrum that is unique to that particular atom and can be used as a "fingerprint" to distinguish that atom from a different one. There are two types of line spectra that you should be aware of. The emission spectrum is a line spectrum that describes the wavelength of light that is emitted by that atom. On the other hand, since atoms can also absorb electromagnetic radiation, there is also the absorption spectrum that describes the light absorbed by the atom. The bright fringes that appear on the emission spectrum correspond to the light emitted by that particular atom while the dark areas are the regions of light not emitted by the atom. On the other hand, the absorption spectrum shows dark lines to represent the light absorbed by the atom and bright lines for the light not absorbed.



SPECTRAL LINES

A line of a particular frequency or wavelength emitted or absorbed by atoms is called a spectral line.

emission spectra were observed for many other elements in the late 19th century, which presented a major challenge because classical physics was unable to explain them. Part of the explanation is provided by Planck's equation, the observation of only a few values of λ (or ν) in the line spectrum meant that only a few values of energy were possible. Thus the energy levels of a hydrogen atom had to be quantized; in other words, only states that had certain values of energy were possible, or allowed.



Balmer Series

In 1885, a Swiss mathematics teacher, Johann Balmer (1825–1898), showed that the frequencies of the lines observed in the visible region of the spectrum of hydrogen fit a simple equation that can be expressed as follows:

$$\frac{1}{\lambda} = R_H\left(\frac{1}{2^2} - \frac{1}{n^2}\right) \qquad n = 3,4,5,6,7$$

$$R_H = rydberg\ constant = 1.09737 \times 10^7\ m^{-1}$$

Lyman Series

$$\frac{1}{\lambda} = R_H \left(\frac{1}{1^2} - \frac{1}{n^2}\right) \qquad n = 2,3,4,5,6,7$$

Paschen Series

$$\frac{1}{\lambda} = R_H \left(\frac{1}{3^2} - \frac{1}{n^2}\right) \qquad n = 4,5,6,7,8$$

Brackett Series

$$\frac{1}{\lambda} = R_H \left(\frac{1}{4^2} - \frac{1}{n^2}\right) \qquad n = 5,6,7,8,9$$

P Fund Series

$$\frac{1}{\lambda} = R_H \left(\frac{1}{5^2} - \frac{1}{n^2}\right) \qquad n = 6,7,8,9$$

THE BOHR'S THEORY

In 1913, Niels Bohr introduced the atomic model to give a quantitative determination of frequency emitted during the de-excitation of an electron in a Hydrogen -atom. The basic assumptions of the Bohr theory as it applies to the hydrogen atom are as follows.

BASIC ASSUMPTIONS OF THE BOHR'S THEORY

1. The electron moves in a circular orbit about the proton under the influence of the coulomb force of attraction.

$$F_{coulomb} = k\,\frac{q_1\,q_2}{r^2} \qquad\qquad F_c = \frac{m\,v^2}{r}$$

2. Only certain electron orbits are stable. These are orbits in which the hydrogen atom does not emit energy. Hence, the total energy of the atom remains constant.
3. An electron moves only in those circular orbits for which its angular momentum $mv\,r$ is an integral multiple of $\frac{h}{2\,\pi}$. Where 'h' is Planck's constant.

$$L = n\left(\frac{h}{2\,\pi}\right)$$

where h is Planck's constant and n = 1,2,3,4,------- is the positive integer (principal quantum number).

4. The atom emits radiation (photon) when the electron makes a transition from a higher energy state (E_n) to a lower energy state (E_p).

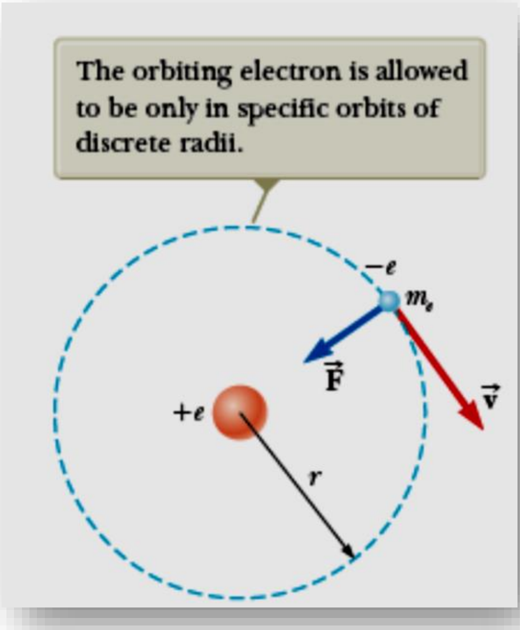
$$hv = E_n - E_p$$

where v is the frequency of emitted photons.

DERIVATION OF THE BOHR RADIUS

According to Bohr's postulates, a hydrogen atom consists of a nucleus containing a proton and an electron revolving around the nucleus in definite circular orbits.

Coulomb's law gives the attractive force between the electron ($q_1 = -e$) and the proton ($q_2 = e$) separated by the orbital radius r



$$F_{coulomb} = k\frac{e\,e}{r^2}$$

$$F_{coulomb} = \frac{k\,e^2}{r^2} \;\ldots\ldots\ldots\ldots\ldots(i)$$

The electron revolving around the nucleus is in uniform circular motion and thus experiences a centripetal force.

$$F_{centripetal} = \frac{m\,v^2}{r} \;\ldots\ldots\ldots\ldots\ldots(ii)$$

The electron can only move in a particular orbit if the above two forces are balanced by each other. Comparing equation (i) and (ii)

$$\frac{k\,e^2}{r^2} = \frac{m\,v^2}{r}$$

$$\frac{k\,e^2}{r^2} = \frac{m}{r} \times v^2 \;\ldots\ldots\ldots(iii)$$

From Bohr's postulate

$$L = n\left(\frac{h}{2\,\pi}\right)$$

$$m\,v\,r = \frac{n\,h}{2\,\pi}$$

$$v = \frac{n\,h}{2\,\pi\,m\,r}$$

Squaring both sides

$$(v)^2 = \left(\frac{n\,h}{2\,\pi\,m\,r}\right)^2$$

$$v^2 = \frac{n^2\,h^2}{4\,\pi^2\,m^2\,r^2}$$

Substituting the expression for v^2 in equation (iii), we get

$$\frac{k\,e^2}{\mathrm{r}^2} = \frac{m}{\mathrm{r}} \times \frac{n^2\,h^2}{4\,\pi^2\,m^2\,r^2}$$

$$\frac{1}{4\,\pi\,\epsilon_0} \times \frac{e^2}{\mathrm{r}^2} = \frac{m}{\mathrm{r}} \times \frac{n^2\,h^2}{4\,\pi^2\,m^2\,r^2}$$

$$\frac{e^2}{4\,\pi\,\epsilon_0} = \frac{1}{\mathrm{r}} \times \frac{n^2\,h^2}{4\,\pi^2\,m}$$

$$\frac{e^2}{4\,\epsilon_0} = \frac{1}{\mathrm{r}} \times \frac{n^2\,h^2}{4\,\pi\,m}$$

$$r = \frac{4\,\epsilon_0}{e^2} \times \frac{n^2\,h^2}{4\,\pi\,m}$$

$$r = \frac{\epsilon_0}{\pi} \times \frac{n^2\,h^2}{e^2\,m}$$

$$r = \frac{n^2\,h^2\,\epsilon_0}{4\,\pi\;e^2\,m}$$

$$\boxed{r_n = \frac{\epsilon_0\;h^2}{\pi\;e^2\,m}\,(n^2)\;\ldots\ldots\ldots..\;(iv) \qquad n = 1,2,3,4,5,\ldots.}$$

THE RADIUS OF THE FIRST ORBIT

The smallest orbit is for n = 1, for the hydrogen atom

$$r_n = \frac{h^2\,\epsilon_0}{\pi\;e^2\,m}\;(n^2)$$

$$r_1 = \frac{(6.626\,\times\,10^{-34})^2\,(8.85\,\times 10^{-12})}{\pi\;(1.6\,\times\,10^{-19})^2\,(9.11\,\times 10^{-31})}\;(1)^2$$

$$r_1 = 0.53\,\times\,10^{-10}\,m$$

Equation (iv) becomes

$$r_n = 0.53 \times 10^{-10} (n^2) \quad \ldots\ldots\ldots\ldots.(v)$$

The radius of the smallest orbit in the hydrogen atom, r_1 is sometimes called the Bohr radius. From Eq(v), we see that the radii of the larger orbits‡ increase as $\mathbf{n^2}$ so

THE RADIUS OF THE SECOND ORBIT

$$r_2 = 0.53 \times 10^{-10} (2^2)$$

$$r_2 = 2.12 \times 10^{-10}\, m$$

THE RADIUS OF THE THIRD ORBIT

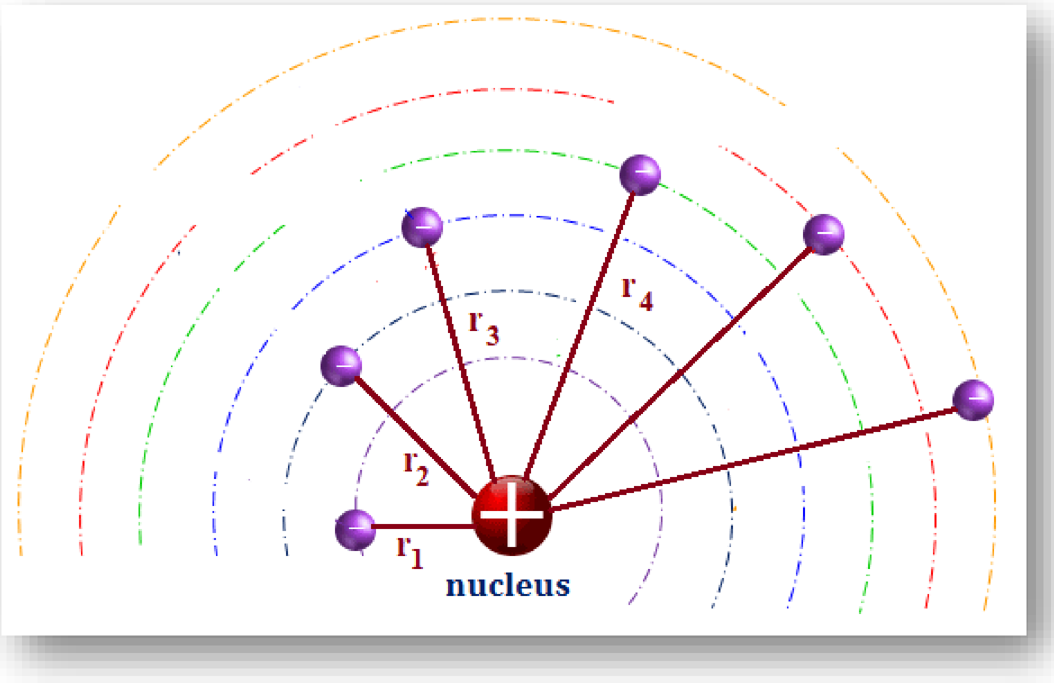
$$r_3 = 0.53 \times 10^{-10} (9^2)$$

$$r_3 = 4.77 \times 10^{-10}\, m$$

THE RADIUS OF THE FOURTH ORBIT

$$r_4 = 0.53 \times 10^{-10} (9^2)$$

$$r_4 = 42.93 \times 10^{-10}\, m$$



ORBITAL ENERGY OF HYDROGEN ATOM

In each of its possible orbits, the electron in a Bohr model atom would have a definite energy, as the following calculation shows. The total energy equals the sum of the kinetic and potential energies.

$$E = K + U \quad \ldots\ldots\ldots\ldots.(i)$$

KINETIC ENERGY

The kinetic energy of the electron is

$$K = \frac{1}{2} m v^2 \qquad \left(m v^2 = \frac{k e^2}{r} \right)$$

$$K = \frac{1}{2} \frac{k e^2}{r}$$

POTENTIAL ENERGY

The electrical potential energy is

$$U = (charge)\,(potential)$$

$$U = (-e)(V) \qquad \left(\therefore \quad \frac{k e}{r} \right)$$

$$U = (-e)\left(\frac{k e}{r^2}\right)$$

$$U = -\left(\frac{k e^2}{r}\right)$$

Substituting the expression of kinetic energy and potential energy in equation (i)

$$E = \frac{1}{2} \frac{k e^2}{r} - \frac{k e^2}{r}$$

$$E = \frac{k e^2 - 2k e^2}{2 r}$$

$$E = -\frac{k e^2}{2 r}$$

$$E = -\frac{k e^2}{2} \left(\frac{1}{r}\right) \quad \dots (ii)$$

Substituting the expression for radius of hydrogen atom from equation (iv) in equation (ii)

$$E = -\frac{k e^2}{2} \left(\frac{1}{\frac{\epsilon_0 \; h^2}{\pi \; e^2 \; m} (n^2)} \right)$$

$$E = -\frac{1}{4 \pi \varepsilon_0} \times \frac{e^2}{2} \times \frac{\pi \; e^2 \; m}{\epsilon_0 \; h^2} \left(\frac{1}{n^2}\right)$$

$$E_n = -\frac{m \; e^4}{8 \; \epsilon_0^2 \, h^2} \left(\frac{1}{n^2}\right)$$

The numerical value of this energy will be

$$E_n = -\frac{13.6\ eV}{n^2}$$

Only energy satisfying this equation (called energy level) is permitted. The lowest allowed energy level called the ground state, has n=1 and energy E_1 = -13.6 eV. The next energy level, the first excited state, has n = 2 and energy $E_2 = \frac{-13.6\ eV}{2^2} = -3.4\ eV$

EXCITATION AND IONIZATION ENERGY

EXCITATION

The process of transferring energy to an atom or molecule, raising it to a higher energy state, often resulting in the emission of photons as it return to its ground state.

IONIZATION ENERGY

The minimum energy required to remove an electron from an atom or molecule, resulting in the formation of an ion.

THE SPECTRUM OF HYDROGEN ATOM

The electron in a hydrogen atom can jump between quantized energy levels by emitting or absorbing Photons for some different values of wavelengths. Any such wavelength is often called a line spectrum which can be absorption or emission lines. The hydrogen lines are said to be grouped into series, according to the level at which upward jumps start and downward jumps end. The formula for these series corresponding to the different wavelengths can be obtained from the equation.

$$E_n = -\frac{m\ e^4}{8\ \epsilon_0^2\ h^2}\left(\frac{1}{n^2}\right) \quad \ldots\ldots\ldots\ldots (i)$$

The frequency of the photon emitted when the electron makes a transition from an orbit to an inner orbit as stated in 3rd postulate

$$E = E_n - E_p$$

$$h\,\nu = -\frac{m\ e^4}{8\ \epsilon_0^2\ h^2}\left(\frac{1}{n^2}\right) - \left[-\frac{m\ e^4}{8\ \epsilon_0^2\ h^2}\left(\frac{1}{p^2}\right)\right]$$

$$h\,\nu = \frac{m\ e^4}{8\ \epsilon_0^2\ h^2}\left(\frac{1}{P^2} - \frac{1}{n^2}\right)$$

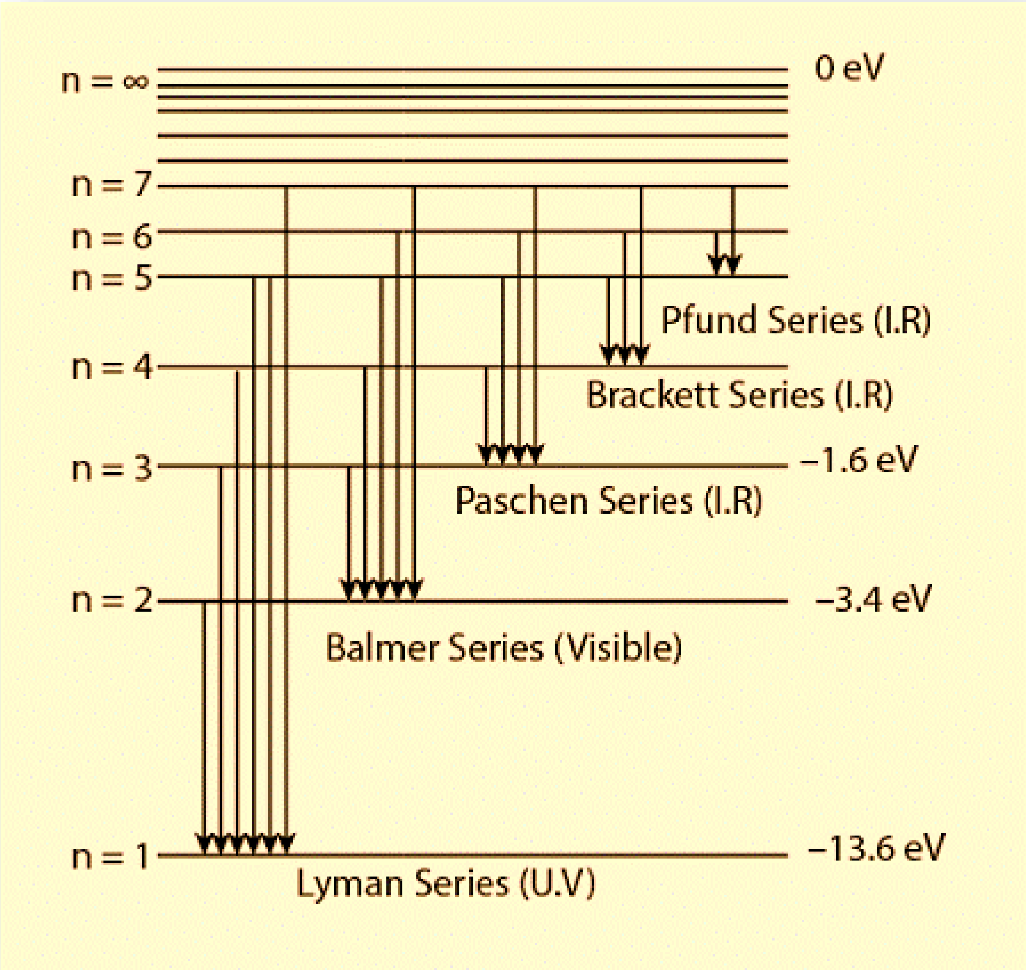
$$\nu = \frac{m\ e^4}{8\ \epsilon_0^2\ h^3}\left(\frac{1}{P^2} - \frac{1}{n^2}\right) \qquad \{c = \nu\,\lambda\} \quad or \quad \nu = \frac{c}{\lambda}$$

$$\frac{c}{\lambda} = \frac{m\ e^4}{8\ \epsilon_0^2\ h^3}\left(\frac{1}{P^2} - \frac{1}{n^2}\right)$$

$$\frac{1}{\lambda} = \frac{m\ e^4}{8\,c\ \epsilon_0^2\ h^3}\left(\frac{1}{P^2} - \frac{1}{n^2}\right)$$

$$where\ \ R_H = \frac{m\ e^4}{8\, c\, \epsilon_0^2\, h^3} = 1.097\ \times\ 10^7\ m^{-1}, is\ called\ Rydberg\ constant.$$

$$\frac{1}{\lambda} = \ \ R_{\ H}\left(\frac{1}{P^2} - \frac{1}{n^2}\right)$$



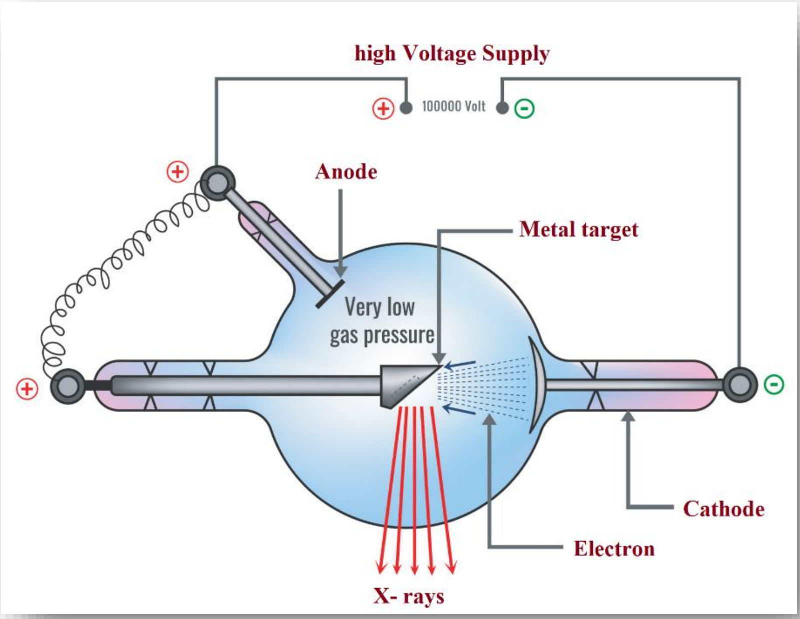
X-RAYS

DEFINITION

X-rays are highly energetic and penetrating electromagnetic radiations produced when charged particles (such as electrons) are decelerated.

X-RAYS PRODUCTION

X-rays are produced when electrons accelerated by a high voltage strike the metal target inside an X-ray tube, as shown in the figure



In this tube cathode 'c' is heated by filament "F' and electrons are given off. These electrons are accelerated toward a target 'T' at a very high voltage (several thousand volts). When they strike the target, X-rays are produced.

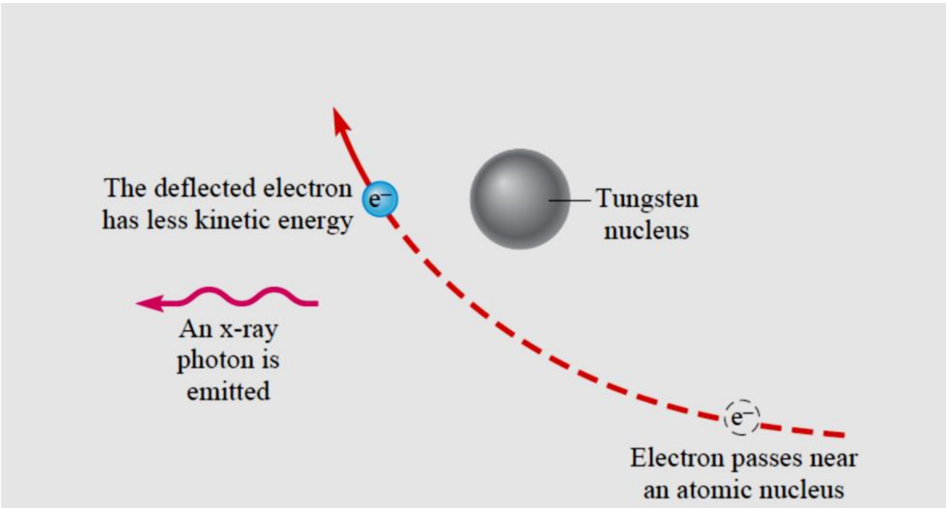
Roentgen was used with low pressure and high voltage. This tube appeared to emit radiation that could penetrate paper, wood, glass, rubber, and even aluminum a centimeter and a half thick. Roentgen could not find out whether the radiation was a stream of particles or a train of waves, he decided to call it X-rays.

THE X-RAY SPECTRUM

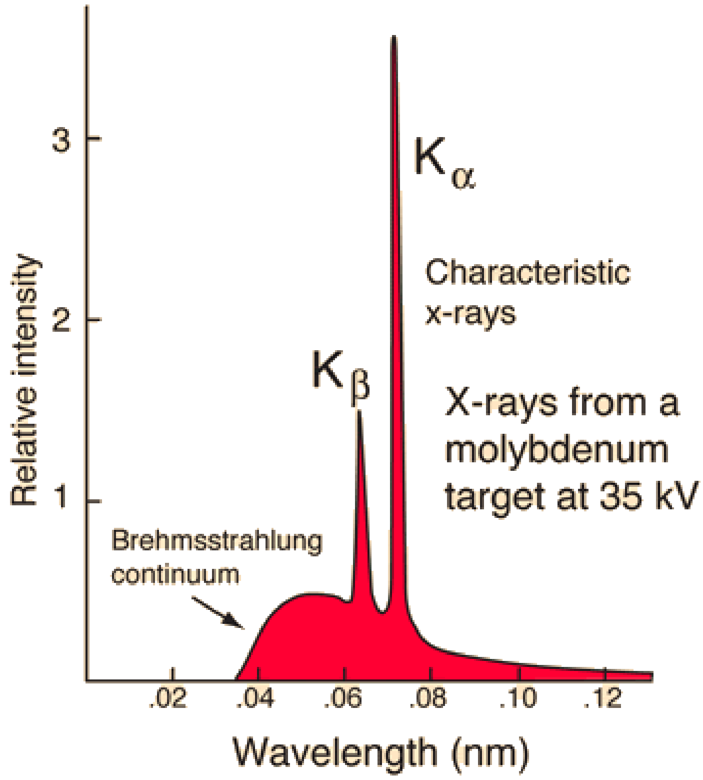
Analysis of X-rays shows that there are two types of X-rays as follows:

THE CONTINUOUS X-RAY SPECTRUM

Consider an electron that scatters from the nucleus of the target atom, and loses kinetic energy. The energy lost by the electron appears as the energy of an X-ray photon that radiates from the metal.



This process is termed BREHMSSTRAHLUNG (German "braking radiation"). The cut-off wavelength λ_0 of the continuous spectrum corresponds to the incident in which an electron loses all of its energy in a single encounter with the target atom. The smooth curve and the cutoff wavelength move to the left as the voltage across the tube increases

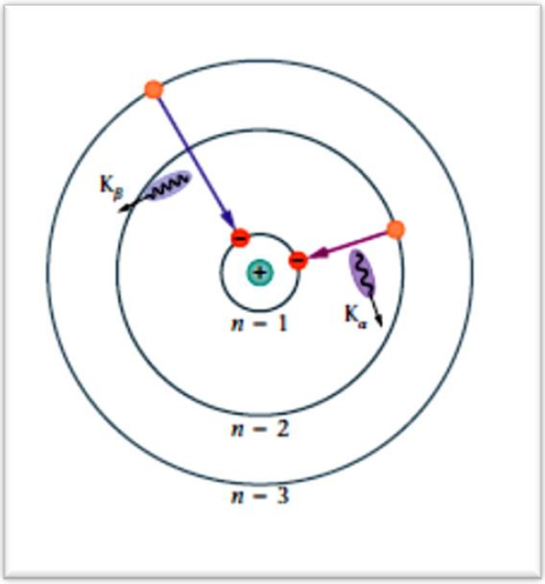


$$K.E = eV$$

$$\frac{h\,c}{\lambda_0} = eV$$

THE CHARACTERISTIC X-RAY SPECTRUM

An energetic incoming electron knocks out one of the inner electrons in a target atom, and produces a vacancy there. One of the outer electrons moves in to fill this vacancy, and in the process, the atom emits a characteristic X-ray photon. If a vacancy in K shell (n = 1) is filled by an electron from the L shell (n = 2), the x-ray is labeled k_α, if an electron falls from the next outermost shell (M shell) we have K_β and so on.



PROPERTIES OF X-RAYS

1- X-rays are neutral, and pass undeleted through the electromagnetic field.

2- They move in a straight line with the speed of light.

3- X-rays are highly energetic of very short wavelengths (0.1 to 1nm).

4- X-rays are invisible to the human eye but produce fluorescence.

5- They produce ionization in gases and eject electrons from metals.

6- They destroy living cells.

LASER [Light Amplification by stimulated Emission of Radiation]

In 1917 Einstein introduced a new concept of stimulated emission, which is the base of the whole laser technology.

Lasers are designed to produce and amplify this stimulated form of light into intense and focused beams. Compared to conventional sources of ordinary light, the light from a laser is quite intense, monochromatic, and emitted in a unidirectional beam limited by diffraction.

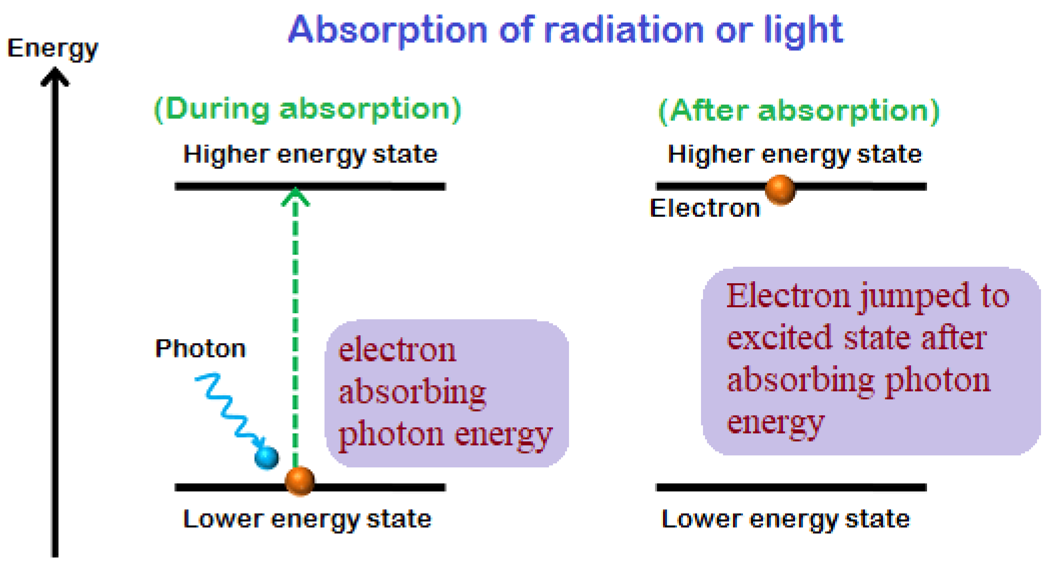
IMPORTANT TERMS:

Some basic terms used in laser operation are as follows:

STIMULATED OR INDUCED ABSORPTION

When an atom absorbs photons of energy $h\nu = E_2 - E_1$, incident on it, in its ground state, the atom reaches one of its allowed excited states. When an atom is induced by the photon (energy packet and transitions to one of its allowed states (excited state) is called Stimulated or induced absorption.

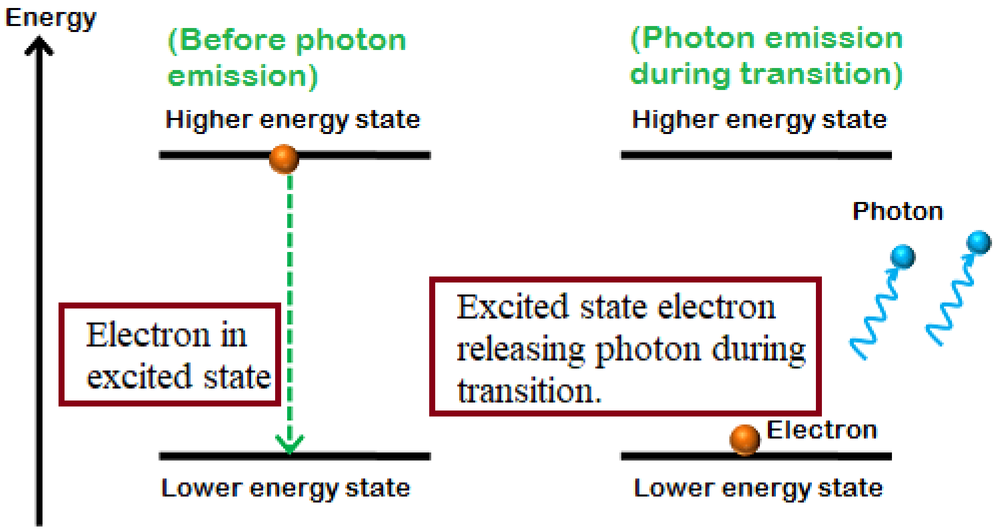
The lifetime of an atom in an excited state is 10^{-8} seconds as shown in Figure



SPONTANEOUS EMISSION

The process of photon emission by an excited atom with no external influences is called spontaneous emission.

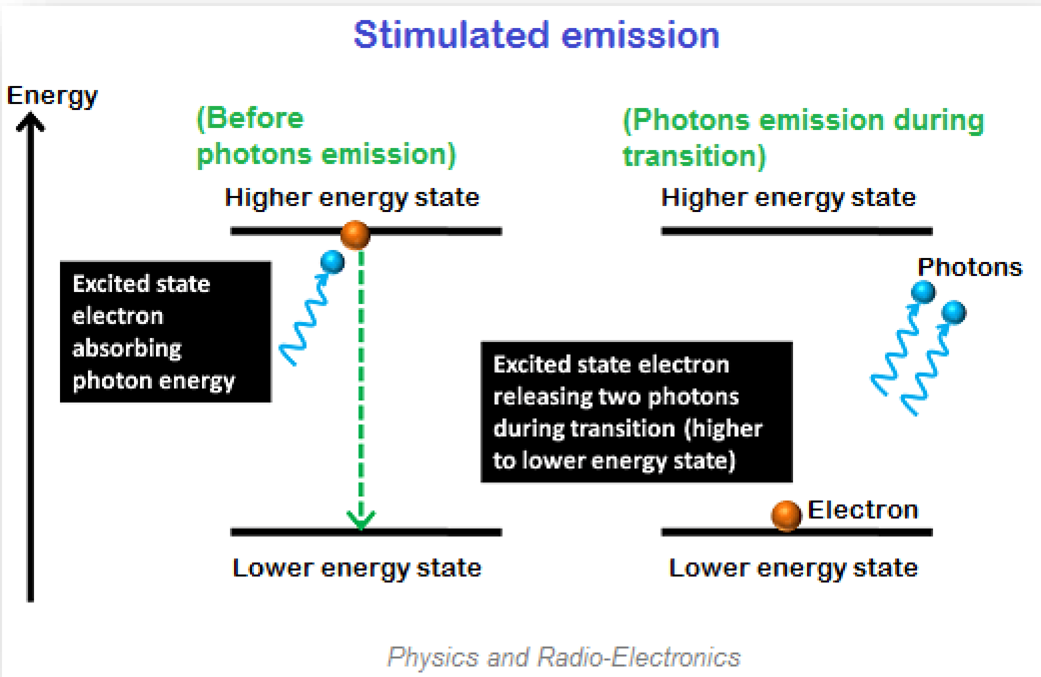
In an excited state, the lifetime of an atom is too short therefore, the probability that the atom in the excited state E_2 will go back to the lower state E_1 by spontaneously emitting the absorbed radiation (E=hυ) is very high. The emitted radiation is incoherent to the induced energy photon as shown in the figure



STIMULATED EMISSION

In this process, if the atom in an excited state E_2, The action of external radiation with frequency $h\nu = E_2 - E_1$, forced a transition to the ground state with emission of one photon with the same energy.

Radiation, which occurs as a result of external exposure, is called induced or stimulated. In the stimulated emission two photons are involved: the primary photon, causing the emission of radiation by an excited atom, and the secondary photon emitted by the atom. These two identical photons will be exactly in phase and coherent. The beam is coherent because all photons are in phase, the beam is monochromatic because the photons all have the same wavelength, and the beam is parallel because the photons all move in the same direction as shown in figure

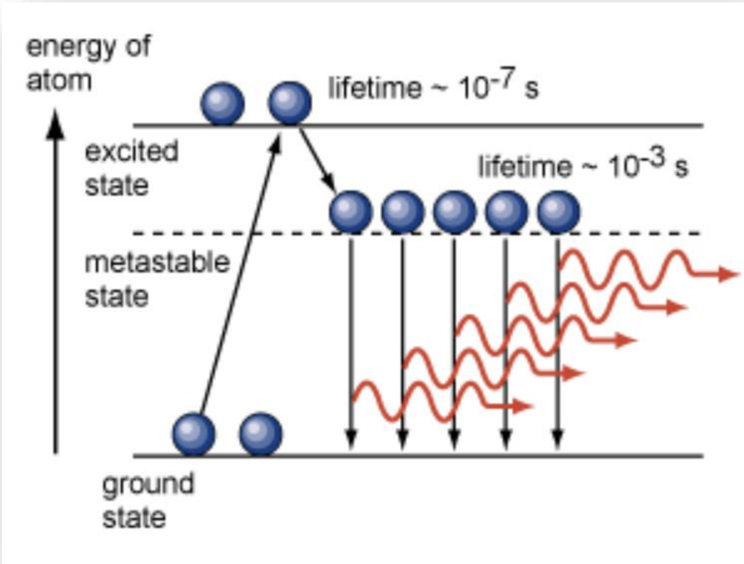


METASTABLE STATE

The mean lifetime t for an ordinary state is of the order of 10-8 s. However, there are some states for which time τ is much longer (10^{-3} s or more). Such states are called as metastable.

POPULATION INVERSION

In an assembly of atoms, the no. of atoms in the ground state is always greater than the number of excited atoms. But artificially a condition can be achieved where the number of excited atoms is greater than in the ground state. This is termed population inversion.

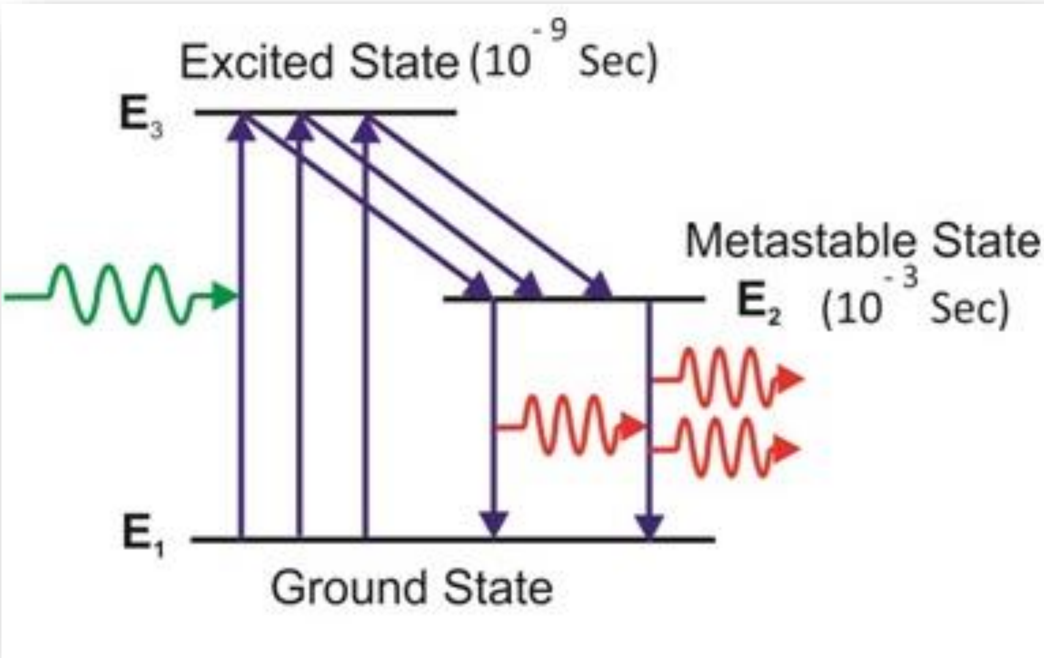


OPTICAL PUMPING

Energy is required by the atoms in the ground state to raise them to a metastable state, that is to attain population inversion. If this energy is supplied by a light beam, the process is named as optical pumping.

LASER PRINCIPLE AND WORKING

A lasing medium can be considered as consisting of atoms ground state, excited state, and metastable state, as shown in the figure.

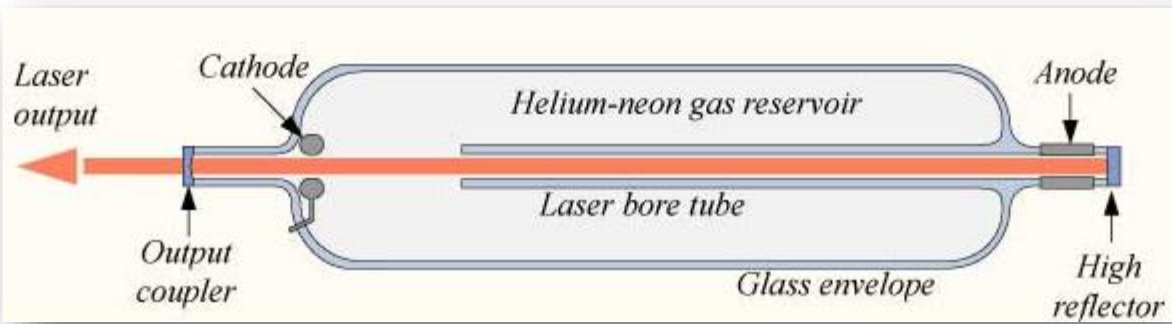


The electrons are excited from ground state E_1 to excited E_3. The electrons jump from an excited state to the metastable state E_2 whose life is 10^{-3} s, due to the continuous excitation the population in the metal stable state increases then the ground state. This condition is called population inversion which is essential for the production of lasers.

Now the photons of energy $\Delta E = E_2 - E_1$ are triggered by which one electron jumps from the metastable state to the ground state emitting Photon, thus two identical photons are produced this process is stimulated emission. Continuing in this manner, the photons undergo a sort of "chain reaction" that doubles the number of photons with each generation. It is this property of stimulated emission that results in light amplification.

He–Ne Gas Laser

The helium-neon laser was the first continuous wave (CW) laser ever constructed. It was built in 1961 by **Ali Javan**, **Bennett**, and **Herriott** at Bell Telephone Laboratories. He-Ne lasers are commonly used in school laboratories and in older barcode readers. The schematic diagram of the He-Ne laser is shown in the figure.



HELIUM-NEON LASER CONSTRUCTION

The helium-neon 1aser consists of three essential components:

PUMP SOURCE (HIGH-VOLTAGE POWER SUPPLY)

The pump energy of the laser is provided by an electrical discharge of several hundred Volts between an anode and cathode at each end of the glass tube. A current of 5 to 100 mA is typical for laser operation.

GAIN MEDIUM (LASER GLASS TUBE OR DISCHARGE GLASS TUBE)

The figure shows a gas discharge tube containing a low- pressure mixture of about 85% He and 15% Ne. The partial pressure of helium is 1 millibar whereas that of neon is 0.1 millibar.

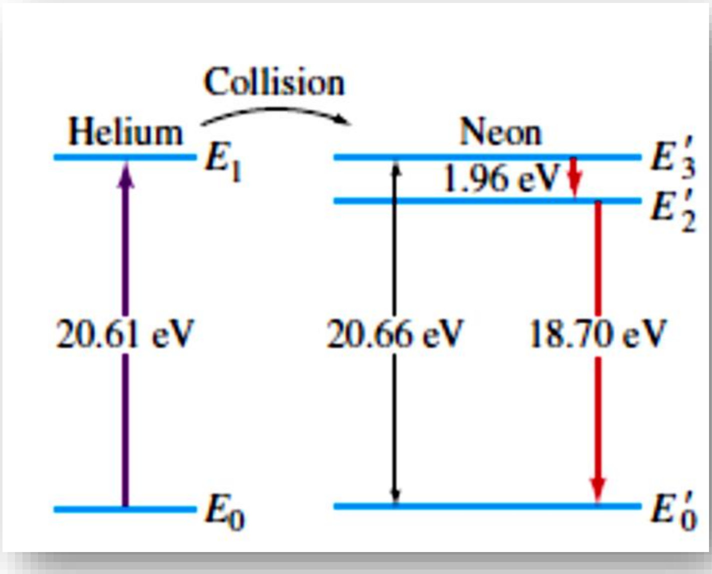
RESONATING CAVITY

The glass tube (containing a mixture of helium and neon gas) is placed between two parallel mirrors. These two mirrors are silvered or optically coated. Each mirror is silvered differently.

The left side mirror is partially silvered and is known as the output coupler whereas the right side mirror is fully silvered and is known as the high reflector or fully reflecting mirror. The fully silvered mirror will completely reflect the light whereas the partially silvered mirror will reflect most of the light.

LASER OPERATION

In a helium-neon laser (He–Ne), the lasing material is a gas, a mixture of about 85% He and 15% Ne. The atoms are excited by applying a high voltage to the tube so that an electric discharge takes place within the gas. In the process, some of the He atoms are raised to the metastable state $\mathbf{E_1}$ shown in Fig,(i) which corresponds to a jump of 20.61 eV, almost exactly equal to an excited state in neon, 20.66 eV. The **He** atoms do not quickly return to the ground state by spontaneous emission, but instead often give their excess energy to a Ne atom when they collide—see Fig(ii). In such a collision, the **He** drops to the ground state and the Ne atom is excited to the state $\mathbf{E_3'}$ (the prime refers to neon states). The slight difference in energy (0.05 eV) is supplied by the kinetic energy of the moving atoms. In this manner, the $\mathbf{E_3'}$state in **Ne**—which is metastable—becomes more populated than the $\mathbf{E_2'}$ level. This inverted population between $\mathbf{E_3'}$ and $\mathbf{E_2'}$ level. Spontaneous and stimulated emission results in the emission of 632.82 nm wavelength light.



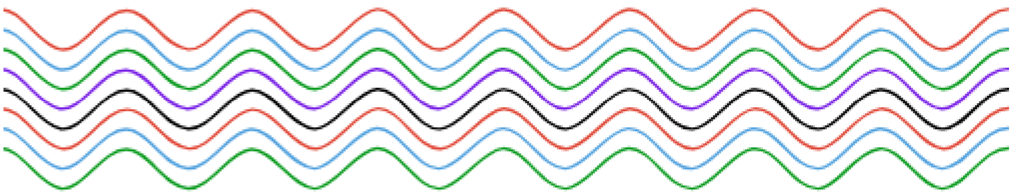
PROPERTIES AND USES OF LASERS:

PROPERTIES OF LASER:

The properties of laser light are very strange as compared to conventional light.

1. MONOCHROMATIC:

The laser emits all photons with the same energy, and thus the same wavelength, it is said to be monochromatic. The light from a laser typically comes from one atomic transition with a single precise wavelength. So the laser light has a single spectral color and is almost the purest monochromatic light available.



HIGHLY INTENSE OR BRIGHT:

The characteristics of coherence and directionality of the laser make laser light highly intense as compared to conventional light. It is the power emitted per unit surface area per unit solid angle. A one-milli-watt He-Ne laser is more intense than the sun's intensity.

COHERENCE:

Laser Light has a high degree of coherence whereas ordinary light is not coherent. This is the unique property of a laser beam. It has arisen due to the stimulated emission process. The emitted photons have a definite phase relation to each other. In laser light, the property of coherence occurs between any two or more light waves. Whereas in conventional light, the property of coherence is exhibited between a source and its virtual source.

DIRECTIONALITY OR DIVERGENCE:

The ordinary source light ray coming from laser light travels in a single direction. However, an ordinary light source travels in all directions. As the beam moves straight and only in one direction, the laser beam can be sharply focused, while light from an ordinary source travels in all directions and in the latter case, the energy intensity rapidly decreases as one moves away from the source similar to the fact the sun's intensity diminishes when it finally reaches the earth.

USES OF LASERS

LASERS IN MEDICINE

Lasers are used for bloodless surgery.
Lasers are used to destroy kidney stones.
Lasers are used in cancer diagnosis and therapy.
Lasers are used for eye lens curvature corrections.
Lasers are used in fiber-optic endoscopes to detect ulcers in the intestines.
The liver and lung diseases could be treated by using lasers.

LASERS IN COMMUNICATIONS

Laser light is used in optical fiber communications to send information over large distances with low loss.
Laser light is used in underwater communication networks.
Lasers are used in space communication, radars, and satellites.

LASERS IN SCIENCE AND TECHNOLOGY

A laser helps in studying the Brownian motion of particles.
With the help of a helium-neon laser, it was proved that the velocity of light is same in all directions.
With the help of a laser, it is possible to count the number of atoms in a substance.
Lasers are used in computers to retrieve stored information from a Compact Disc (CD).
Lasers are used to store large amounts of information or data in CD-ROM.

LASERS IN MILITARY

Laser range finders are used to determine the distance to an object.
The ring laser gyroscope is used for sensing and measuring very small angles of rotation of moving objects.
Lasers can be used as a secretive illuminator for reconnaissance during the night with high precision.
Lasers are used to dispose of the energy of a warhead by damaging the missile.
Laser light is used in LIDARs to accurately measure the distance to an object.

BEAM-RELATED HAZARDS

Improperly used laser devices are potentially dangerous. Effects can range from mild skin burns to irreversible injury to the skin and eye. The biological damage caused by lasers is produced through thermal, acoustical, and photochemical processes.
Thermal effects are caused by a rise in temperature following the absorption of laser energy.

The severity of the damage is dependent upon several factors, including exposure duration, wavelength of the beam, energy of the beam, and the area and type of tissue exposed to the beam.

Acoustical effects result from a mechanical shockwave, propagated through tissue, ultimately damaging the tissue. This happens when the laser beam causes localized vaporization of tissue, causing the shockwave analogous to ripples in water from throwing a rock into a pond.

GENERAL SAFETY PROTOCOLS

Following are some general safety protocols that have to be taken into consideration while working with lasers.

► Only trained, authorized personnel may operate lasers, Authorization is received from the authorized laser user and the Laser Safety Officer.

► NEVER put yourself into any position where your eyes approach the axis of a laser beam (even with eye protection on).

► Keep beam paths below or above standing or sitting eye level. Do not direct them towards other people.

► Do not damage laser protective housings, or malfunctioned the interlocks on these housings.

► Eliminate all reflective material from the vicinity of the beam paths.

► Never use viewing instruments to look directly into a laser beam. If this is necessary, install an appropriate filter into the optical element assembly.

► Keep ambient light levels as high as operations will permit.